



ICAO

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Asia and Pacific Office

Twentieth Meeting of the Asia Pacific Regional Aviation Safety Team (APRAST/20)

(Bangkok, Thailand, 07-11 August 2023)

Agenda Item 5: Presentations – State / Industry / ICAO

A COLLABORATIVE AND DATA-DRIVEN APPROACH TO MITIGATING THE RISK OF GROUND TAXI INCIDENTS

(Presented by Singapore)

SUMMARY

Ground taxi incidents, such as taxi errors, are generally considered events with a low safety risk. However, if left unchecked, they could propagate into events with more severe outcomes.

During the first half of 2022, Singapore Changi Airport experienced an uptrend of taxi errors. Together with the airport operator and other stakeholders, the Civil Aviation Authority of Singapore took a collaborative and data-driven approach to identify, analyse, and address these incidents.

The Meeting is invited to:

1. Note the approach taken to identify and address a specific safety trend and the strategies to understand and mitigate the associated contributing factors.
2. Call for States/Administrators and the industry to share safety trends observed in taxi errors, the associated contributing factors, and mitigations efforts.
3. Call on the SEI WG to note some of the novel mitigations that have shown to be effective and consider including them in the relevant Runway Safety guidance material.

1. INTRODUCTION

1.1 Although taxi errors are often considered to have a low safety risk, they can be considered precursors to runway incursions and ground collisions. The attention of the aviation community is required to ensure these events do not impact the safety of aircraft operations.

1.2 Taxi errors see varied contributing factors, which can be divided into four broad areas:

- a) Controller error – the controller mistakenly provides incorrect instructions to the flight crew;

- b) Communication error – the controller provides the correct information to the flight crew but between the issuance of the clearance and the receipt by the pilots there is misinterpretation that leads to a deviation from the intended clearance;
- c) Flight crew error – the controller’s instructions are heard and correctly read back but the instructions are not followed; or
- d) Latent aerodrome layout issues – complex junctions due to the evolution and growth of an aerodrome.

1.3 The ground taxi phase is a high workload environment for both the flight crew and the controllers. Whilst the safe manoeuvring of the aircraft remains a priority for both the flight crew and the controller, flight crew, for example, must simultaneously conduct a range of other tasks such as adjusting aircraft performance and navigation information. Controllers need to also focus on deconflicting with other ground movements. This can lead to task saturation and degradation of situational awareness. When combined with complex aerodrome layouts, this can increase the likelihood of errors occurring. Action is necessary to support flight crew and controllers such that their attention can be appropriately dedicated to ground manoeuvring.

1.4 The contributing factors that lead to taxi errors also challenge the preventative control measures designed to mitigate runway incursions and ground collisions. If allowed to propagate, such errors can lead to a risk of normalisation of deviance.

1.5 This paper considers data analysis as a tool for identifying occurrence trends and discusses an approach taken to mitigate the adverse safety trends associated with taxi errors.

2. DISCUSSION

2.1 The Civil Aviation Authority of Singapore (CAAS) implemented a three-pronged approach to addressing this issue:

Leveraging on data analytics

2.2 CAAS adopts a data-driven approach to identifying and mitigating safety risks. Our safety data collection and processing system entails analysis of safety trends through different parameters such as occurrence type, area, aircraft registration, aircraft type, contributing factor, etc. Tapping on data analytics tools, such as Tableau, facilitated the early recognition of an increasing trend of taxi errors occurring at Singapore Changi airport.

2.3 A team comprising safety officers and industry representatives from flight operations, air traffic services, and aerodrome regulation was formed to interpret and analyse the reports, identify possible contributing factors and develop safety mitigations. The reports generated from occurrences were corroborated with those generated by air traffic controllers. The resulting output and the associated narratives were used to generate a series of analytical views. Each view was designed to answer a question developed by the analytics team.

2.4 A sample of the questions can be seen below along with the associated view:

- a) Are the errors associated with pilots having a lack of familiarity with the aerodrome layout?
- b) Which taxiway junctions are most effected?

- c) What type of error is occurring? Is it a missed junction, wrong direction of turn, or communication error?
- d) What are the main contributing factors? Controller error, communication error, or pilot error?
- e) Has the reduction in flying contributed to a loss of familiarity by flight crew and controllers with the aerodrome layout?

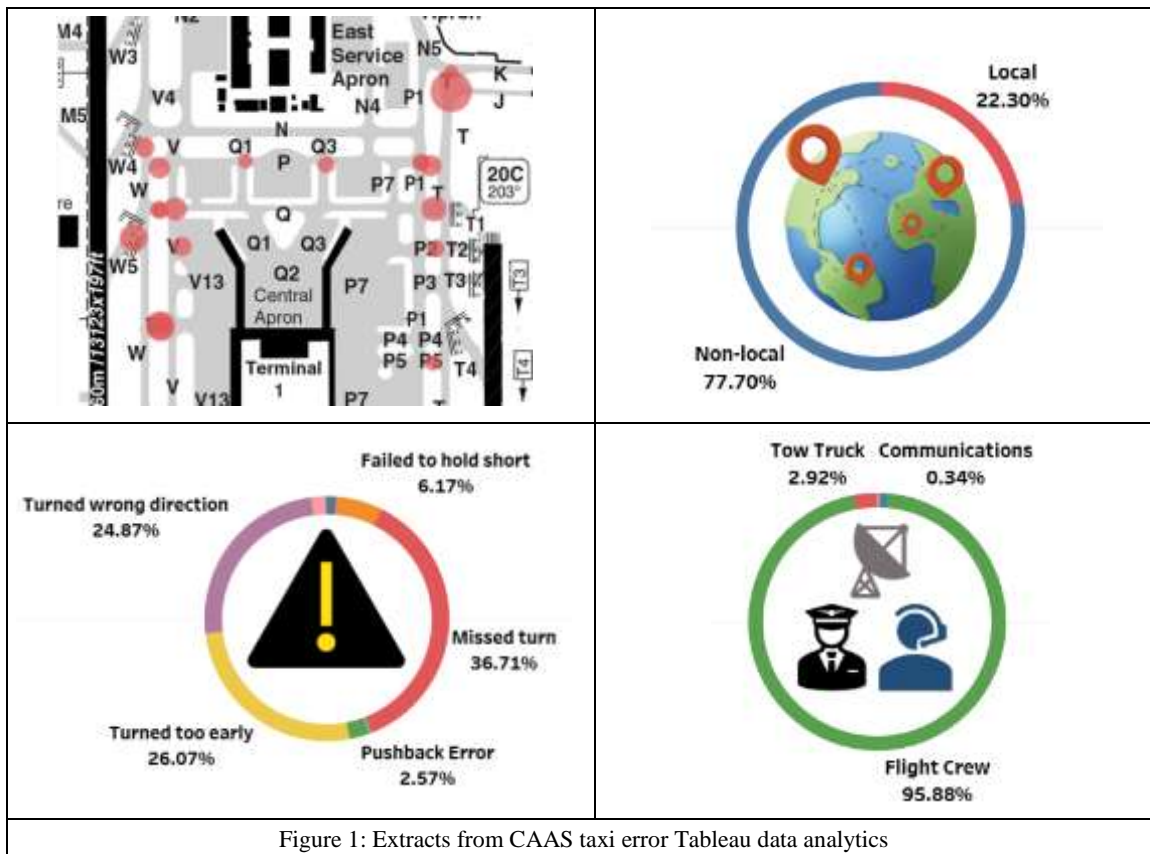
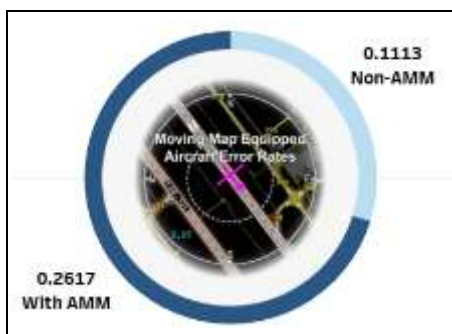


Figure 1: Extracts from CAAS taxi error Tableau data analytics

2.5 Certain results warranted a targeted deep-dive approach based on known factors. An example of this was to answer the question of whether aircraft moving-map (AMM) display functionality assisted with the prevention of taxi errors. The study was narrowed to focus on Singapore operators based on known aircraft equipage.

2.6 When normalised against the number of flight cycles, the errors rates were surprisingly contrary to the expectation of the aircraft AMM display improving situational awareness.



2.7 Further analysis of the effectiveness of moving-map displays and other open questions were put to flight crew during voluntary interviews to comment on the applicable contributing factors and provide further insights where possible. The comments from flight crew indicated a tendency to over rely on the aircraft AMM display without confirmation via external reference. Additionally, some AMM maps were unable to accurately represent complex junctions which caused confusion for the flight crew.

Cross-agency collaboration and consultation

2.8 The analytics team referenced in point 2.3 was subsequently formalised into a Taxi Error Working Group (TEWG) with an expanded membership including local and foreign airlines, the airport operator, the air traffic control service provider, and regulators from other disciplines such as safety policy.

2.9 The TEWG assessed that most of the taxiing errors resulted from incorrect execution of air traffic control instructions by the flight crew despite correct readback. The key contributing factor identified was the flight crews' unfamiliarity with taxiway names and the aerodrome layout after a hiatus from flying into Changi Airport due to the COVID-19 pandemic. Additionally, the complexity of certain junctions was shown to have contributed to errors made when operating during high workload events.

2.10 After identifying the key reasons for such errors, the TEWG focused on developing the necessary mitigation actions.

Taking mitigation actions

2.11 Short-term mitigation measures focused on raising awareness amongst the pilot and air traffic controller community. These were implemented immediately after the trend was observed and took the form of direct communication with the community. Progressively, information flashes, posters, and other visuals were developed, which included the sharing of best practices and information on the location of potential hot spot areas.

2.12 Mid-term solutions focused on pilot and controller training to mitigate some latent contributing factors, such as distraction, complacency, workload management, task sharing, AMM usage, and "heads-down" tasks. For flight crews, these took the form of Computer Based Training learning modules that focused on awareness, best practices, and community feedback. For air traffic controllers, human performance factors with relation to complex, truncated, or lengthy clearances were reinforced.

2.13 Broader industry engagements were also conducted through a CAAS Safety Series seminar. The online seminar shared the outcomes of the data analysis, identifying contributing factors, and sharing effective techniques and mitigations from the flight operations, air traffic, and aerodrome perspectives. All operators at Changi airport were invited to attend and contribute. The participants found the sharing relevant and useful, and the sessions are now run annually.

2.14 Longer-term measures have included searching for novel solutions and best practices internationally. One such measure was the painting of ground taxiway markings directly onto the taxiway. The TEWG implemented a limited trial at key hotspot locations to gauge effectiveness. This was followed up with a specific analysis of the taxi error rate at the hotspot locations, feedback from pilots, and a discussion with the TEWG pilot representatives. The taxiway markings have resulted in a 60% reduction in errors occurring at the junctions where they were implemented.



3. INTERNATIONAL DATA SHARING AND COLLABORATION

3.1 Taxi errors are a common problem internationally. This issue is of particular interest to airports in the region. The sharing of the taxi error information by States will be beneficial to each State's data analysis and threat mitigations.

3.2 ICAO Doc 9870 – Manual on the Prevention of Runway Incursions – highlights the need for the international exchange of information to improve global aviation safety.

4. ACTION BY THE MEETING

4.1 The Meeting is invited to:

- a) Note the approach taken to identify and address a specific safety trend and the strategies to understand and mitigate the associated contributing factors;
- b) Call for States/Administrations and the industry to share safety trends observed in taxi errors, the associated contributing factors, and mitigations efforts; and
- c) Call on the SEI WG to note some of the novel mitigations that have shown to be effective and consider including them in the relevant Runway Safety guidance material.

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